A brief overview of the Summit Framework

The Team

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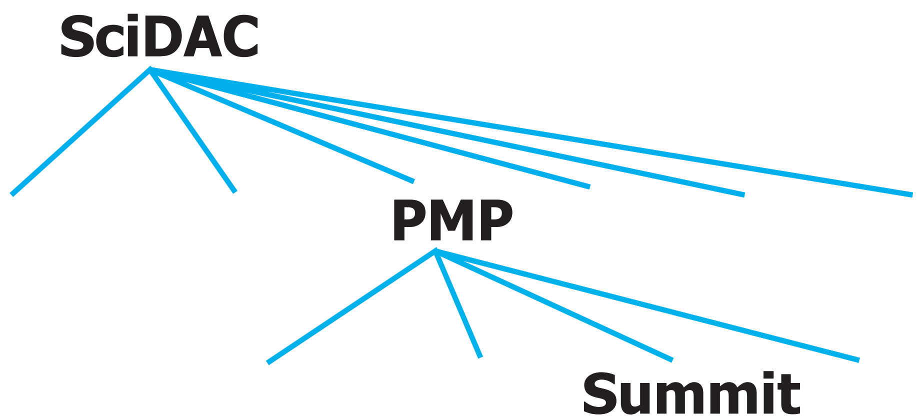
Summit:

"Summit is an open-source framework for both local and global massively parallel gyrokinetic turbulence simulations with kinetic electrons and electromagnetic perturbations. Summit is part of the Plasma Microturbulence SciDAC Project."

from: www.nersc.gov/scidac/summit



Current work, features, physics

Realistic magnetic equilibrium (Leboeuf, Dimits, Shumaker)

Framework design, design of objects and methods (Decyk)

Quasi-ballooning coordinates (Dimits)

Electron fluid hybrid model with kinetic closure, electromagnetic, moderate beta (Cohen, Parker)

Full electron dynamics, both electrostatic and electromagnetic
(Chen, Parker, Cohen)

e-i and i-i collisions (Chen)

Future work

Global effects (Leboeuf, Dimits, Shumaker)

Compressional component to B (Chen, Parker, Cohen)

Particle-continuum hybrid method (Vadlamani, Parker)

Why bother?

GK simulators are really driven by solving unsolved problems.

GK simulators are forced into a routine of continually adding physics to keep their code competitive. If there are 6 codes, that means 5/6 times the scientist is solving a problem with an already existing solution.

Solution

A software framework where the scientist can add his/her physics and tap existing features when/if needed.

Pitfalls

All gk simulators want to solve the same unsolved problem. (not an issue)

Why should I share my code features? (not an issue)

My existing code runs great, what is the (short term) payoff to install my features and get running within the framework? (big issue)

One massive code, little inovation, no cross-checks. (not an issue)

Integration into framework is gradual, benchmarking at every step

```
!  LLNL/CU/UCLA Gyrokinetic Framework

!  All codes should use this main program
!  and call input.F at this time

 program main_program
□   □   .
□   □   .
□   □   .

!-------------------------------------------------
!    initilization

 call mpi_setup
 call timer_setup

 call initialize(runsteps,nt)

        if (start) then
          call loader_wrapper
        else
          call restart_wrapper
        endif
```

```
!-------------------------------------------------
!    main time loop

     ipush=1
     do timestep=1,runsteps

       nt = nt + 1
       t = (nt - 1)*dt

         call accumulate

         call poisson(timestep-1,ipush)

         call efield

!    predictor push
         ipush=0

         call push_wrapper(timestep,ipush)

         call accumulate

         call poisson(timestep,ipush)
□   □   .
□   □   .
□   □   .
```

Summit Kinetic Electron Results (See Chen 1C35)

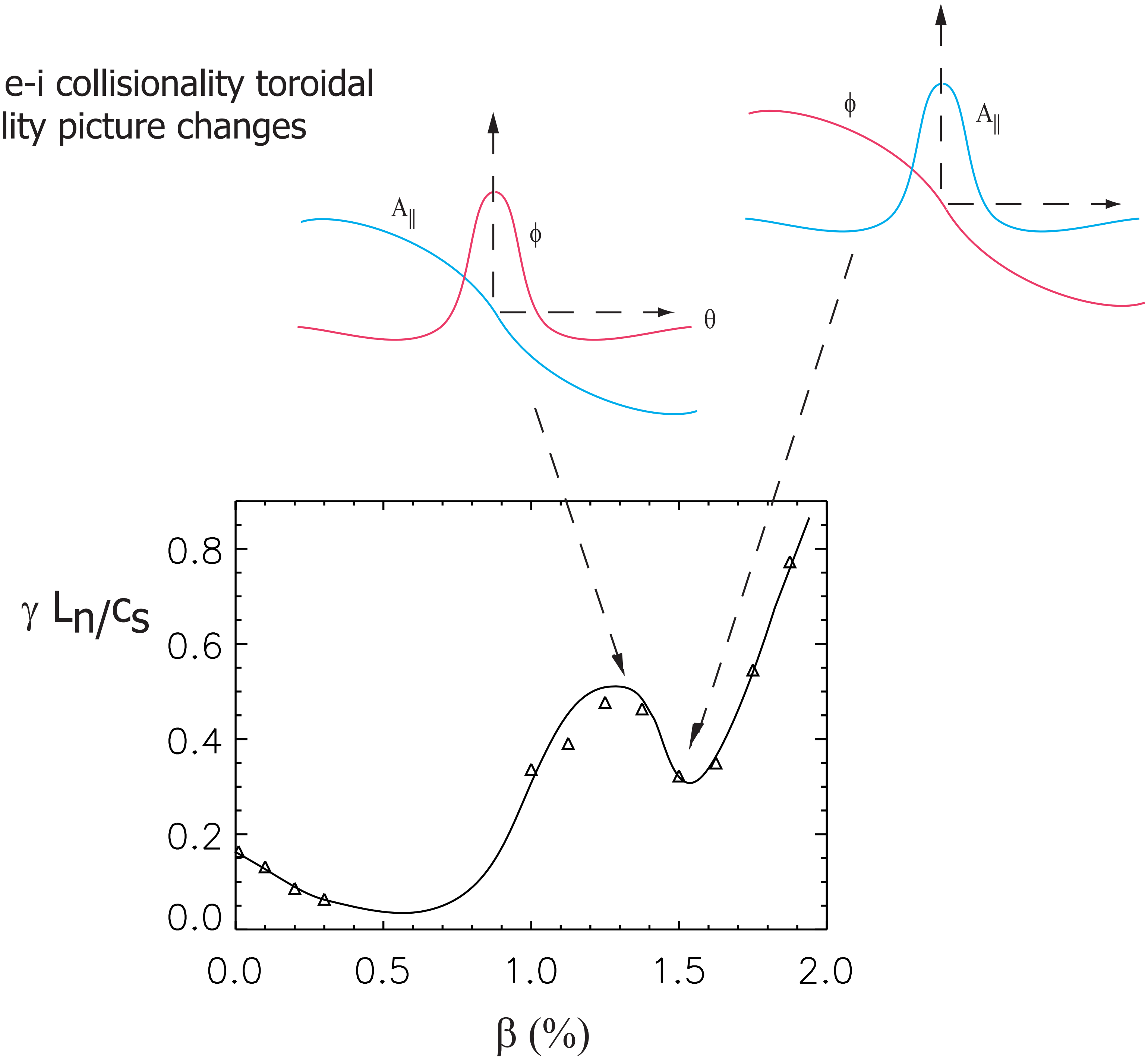
Electrostatic (very low beta electromagnetic) simulations with fully **kinetic electrons**

☐ - χ_i higher
☐ - Critical gradient lower
☐ - Sub-critical region still present
☐ - Turbulence more broad-band, zonal flow less pronounced
☐ - Weak e-i collisionality is important (experimental values)☐ Dorland et al. TTF 2001

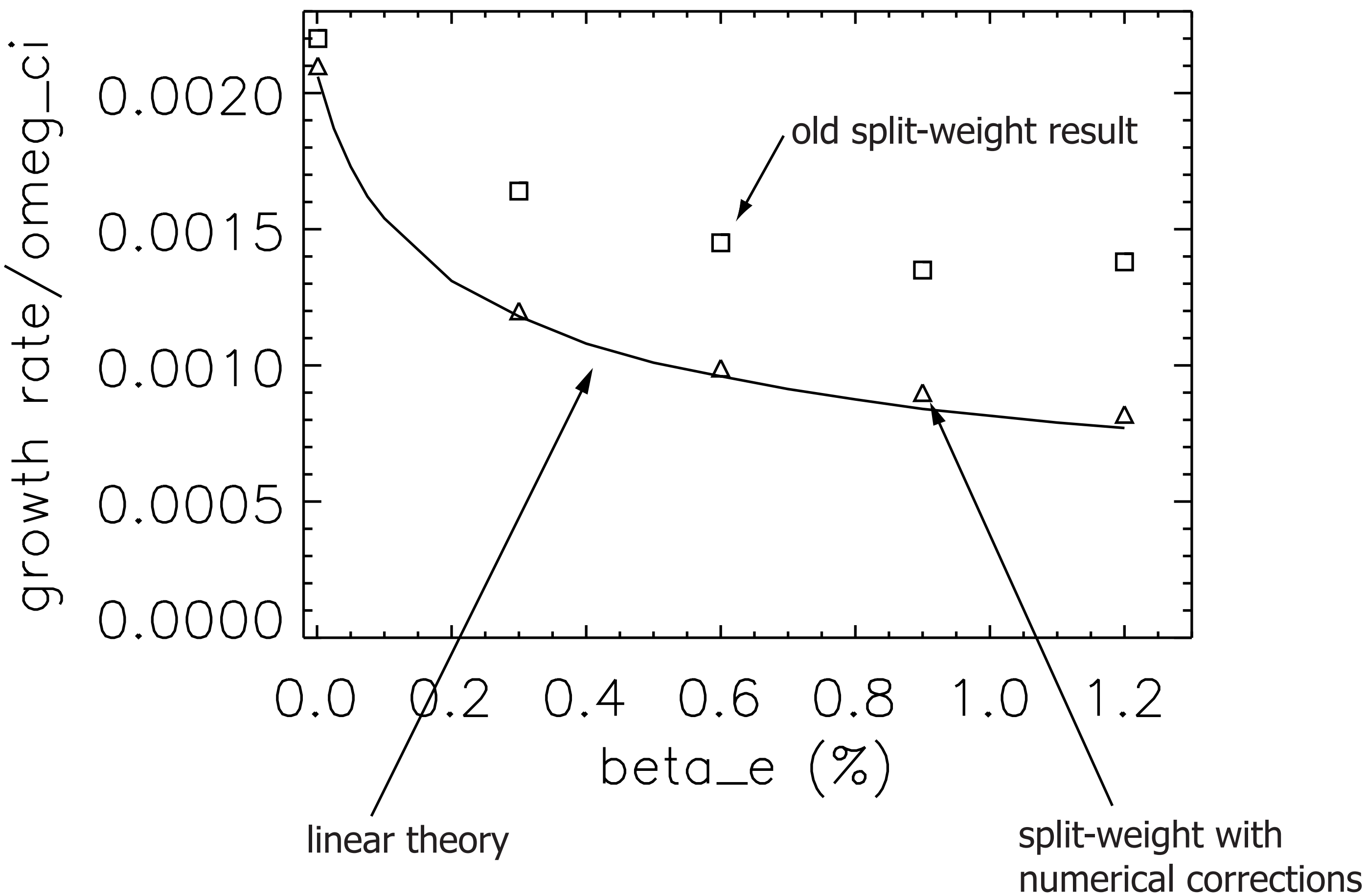
Moderate-β **electromagnetic** simulations with **kinetic electrons** now working linearly

☐ - "Moderate-β numerical problem" fixed
☐ - Weak e-i collisionality is important at moderate β
☐ - Further work needed to understand nonlinear saturation mechanism(s)
☐ - **Timestep only 1/3 small than adiabatic electron case!**

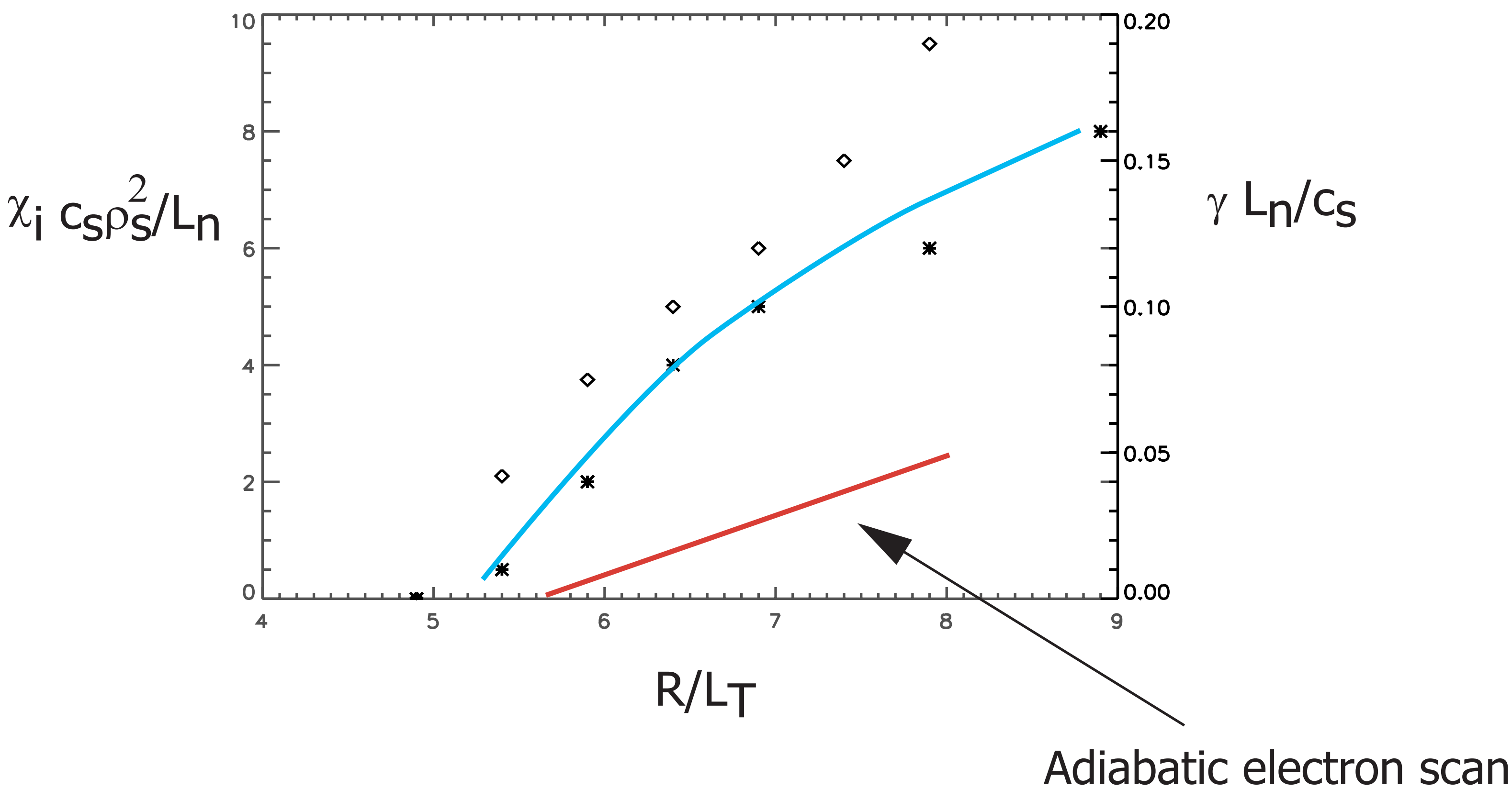
With weak e-i collisionality toroidal linear stability picture changes



Electromagnetic gyrokinetic particle simulation working linearly at moderate beta.



Critical gradient is lower with kinetic electrons, sub-critical region still exists.



Summit posters this meeting

1C10 Progress Towards Realistic Geometry and Global Implementations of the Summit Gyrokinetic Framework (**Leboeuf**, Dimits, Shumaker)

1C29 Further Work with the Unified Particle-in-Cell and Continuum Method (**Vadlamani**, Parker, Chen, Kim)

1C29 Sources and Sinks in the Evolution of Zonal Flows in Toroidal Ion Temperature Gradient Turbulence (**Dimits**, Shumaker, Nevins)

1C35 Progress on Electromagnetic Gyrokinetic Simulations of Microturbulence with Fully Kinetic Electrons (**Chen**, Parker)

2C03 Anomalous Electron Thermal Transport from Overlapping and Non-Overlapping Drift Magnetic Islands (**Sydora**)